

What is claimed is:

1. A hollow microsphere comprising a polymeric shell, wherein the thickness of said shell varies less than 10%.

2. The microsphere of claim 1, wherein said shell thickness varies less than 5%.

5 3. The microsphere of claim 1, wherein said shell thickness varies less than 1%.

4. The microsphere of claim 1, wherein said shell thickness varies less than 0.5%.

5. The microsphere of claim 1, wherein said shell thickness is in the range of 100-1000 nm.

10 6. The microsphere of claim 1, wherein said shell thickness is in the range of 150-250 nm.

7. The microsphere of claim 1, wherein said shell thickness is in the range of 350-450 nm.

8. The microsphere of claim 1, wherein said shell thickness is in the range of 550-650 nm.

15 9. The microsphere of claim 1, wherein said microsphere is substantially devoid of silica.

10. The microsphere of claim 1, wherein said microsphere comprises a pore, said pore having a size in the range of 10 -500 nm.

11. The microsphere of claim 1, wherein said microsphere comprises an organic dye.

12. The microsphere of claim 11, wherein said dye is an Azo dye.

20 13. The microsphere of claim 11, wherein said dye is selected from the group consisting of Indigo Blue, Lissamine Green B, VAT Green 1, VAT Yellow 4, VAT Violet 1, Anthrasol, Blue IBC, Indigosol Pink IR, Indigosol Grey IBL, Anthrasol Brown IBR, and Red 146.

14. The microsphere of claim 1, wherein said microsphere comprises a protecting agent.

15. The microsphere of claim 1, wherein said microsphere comprises a therapeutic agent.

25 16. The microsphere of claim 15, wherein said therapeutic agent is selected from the group consisting of a polypeptide, an antibody, an enzyme, a nucleic acid, and a small molecule drug.

17. The microsphere of claim 1, wherein said shell comprises an acrylate polymer.

18. The microsphere of claim 1, wherein said shell comprises a methacrylate polymer.

30 19. The microsphere of claim 1, wherein said shell comprises a styrene polymer.

20. The microsphere of claim 1, wherein said shell comprises a polymer of one or more monomers selected from the group consisting of acrylonitrile, styrene, benzyl methacrylate, phenyl methacrylate, ethyl methacrylate, divinyl benzene, 2-Hydroxyethyl methacrylate, cyclohexyl methacrylate, p-methyl styrene, acrylamide, methacrylamide, methacrylonitrile, hydroxypropyl methacrylate, methoxy styrene, N-acrylylglycinamide, and N-methacrylylglycinamide.

21. The microsphere of claim 1, wherein said shell comprises a co-polymer selected from the group consisting of styrene-PMMA, benzyl methacrylate-PMMA, styrene-PHEMA, styrene-PEMA, styrene-methacrylate, and styrene-butylacrylate.

22. The microsphere of claim 1, wherein said polymeric shell comprises a cross-linked polymer.

23. A method for preparing a hollow microsphere, comprising:  
providing a substrate comprising a plurality of hydroxyl groups;  
attaching an initiator agent to said hydroxyl groups to form attached initiator agents;  
reacting the attached initiator agents with a polymerizable unit under living polymerization conditions to form a polymer shell over said substrate, said polymerization being confined to a surface of said substrate; and  
exposing said substrate to an etching agent for a time sufficient to allow for removal of said substrate from said polymeric shell to form a hollow microsphere.

24. The method of claim 23, wherein said substrate is silica.

25. The method of claim 23, wherein said substrate is selected from the group consisting of silica, alumina, mica, and clay.

26. The method of claim 23, further comprising exposing said polymer shell to a crosslinking agent.

27. The method of claim 23, wherein said polymerizable unit is selected from the group consisting of acrylonitrile, styrene, benzyl methacrylate, phenyl methacrylate, ethyl methacrylate, divinyl benzene, 2-hydroxyethyl methacrylate, cyclohexyl methacrylate, p-methyl  
5 styrene, acrylamide, methacrylamide, methacrylonitrile, hydroxypropyl methacrylate, methoxy styrene, N-acrylylglycinamide, and N-methacrylylglycinamide.

28. The method of claim 23, wherein said polymerizable unit is selected from the group consisting of styrene-PMMA, benzyl methacrylate-PMMA, styrene-PHEMA, styrene-PEMA,  
10 styrene-methacrylate, and styrene-butylacrylate.

29. A method for preparing a hollow microsphere, comprising:  
providing a microsphere substrate;  
contacting said microsphere substrate with a polymer nanosphere to yield a  
15 colloidal assembly;  
heating said assembly to yield a core-shell composite; and  
exposing said composite to an etching agent for a time sufficient to allow for removal of said core from said shell to form a hollow microsphere.

20 30. The method of claim 29, wherein said microsphere 1-100  $\mu\text{m}$  in diameter.

31. The method of claim 29, wherein said microsphere is 3-10  $\mu\text{m}$  in diameter.

25 32. The method of claim 29, wherein said nanosphere is 1-500 nm in diameter.

33. The method of claim 29, wherein said nanosphere is 100-200 nm in diameter.

30 34. The method of claim 29, wherein said nanosphere comprises an amine-modified polymer and said microsphere comprises an aldehyde-modified composition.

35. The method of claim 29, wherein said nanosphere comprises an amine-modified polystyrene and said microsphere comprises glutaraldehyde-activated silica.

36. The method of claim 29, wherein said nanosphere comprises avidin and said microsphere comprises biotin.

37. The method of claim 29, wherein said nanosphere comprises polystyrene.

38. The method of claim 29, wherein said polymer nanosphere comprises a mixture of a polystyrene nanosphere and a poly (methylmethacrylate) nanosphere.

39. The method of claim 29, wherein said colloidal assembly is heated to a temperature greater than the glass transition temperature of said polymer nanosphere.

40. A method for preparing a core-shell composition, comprising:  
providing a microsphere substrate;  
contacting said microsphere substrate with a polymer nanosphere to yield a colloidal assembly; and  
heating said assembly to yield a core-shell composition.

41. The method of claim 40, wherein said microsphere is 1-100  $\mu\text{m}$  in diameter.

42. The method of claim 40, wherein said microsphere is 3-10  $\mu\text{m}$  in diameter.

43. The method of claim 40, wherein said nanosphere is 1-500 nm in diameter.

44. The method of claim 40, wherein said nanosphere is 100-200 nm in diameter.

45. The method of claim 40, wherein said nanosphere comprises an amine-modified polymer and said microsphere comprises an aldehyde-modified composition.

46. The method of claim 40, wherein said nanosphere comprises an amine-modified polystyrene and said microsphere comprises glutaraldehyde-activated silica.

5 47. The method of claim 40, wherein said nanosphere comprises avidin and said microsphere comprises biotin.

48. The method of claim 40, wherein said nanosphere comprises polystyrene.

10 49. The method of claim 40, wherein said polymer nanosphere comprises a mixture of a polystyrene nanosphere and a poly (methylmethacrylate) nanosphere.

50. The method of claim 40, wherein said colloidal assembly is heated to a temperature greater than the glass transition temperature of said polymer nanosphere.

15 51. A core-shell composition, wherein the thickness of said shell varies less than 10%.

52. The composition of claim 51, wherein said shell comprises a polymer.

20 53. The composition of claim 51, wherein said core comprises a silica.

54. The composition of claim 51, wherein said shell thickness varies less than 5%.

55. The composition of claim 51, wherein said shell thickness varies less than 1%.

25 56. The composition of claim 51, wherein said shell thickness varies less than 0.5%.

57. The composition of claim 51, wherein said shell thickness is in the range of 100-1000 nm.

30 58. The composition of claim 51, wherein said shell thickness is in the range of 150-250 nm.

59. The composition of claim 51, wherein said shell thickness is in the range of 350-450 nm.

5           60. The composition of claim 51, wherein said shell thickness is in the range of 550-650 nm.

10